VEHICLE AIR BAG MODULE RETENTION SYSTEM

TECHNICAL FIELD

[0001] This invention relates to fastening elements for retaining an air bag module to a steering wheel armature, the fastening elements including a spring configured to provide snap-in retention of the air bag module to the steering wheel armature, to bias the air bag module in a first position in which a switch is open, and to deform with sufficient force to enable the air bag module to move to a second position in which the switch is closed.

BACKGROUND OF THE INVENTION

[0002] The prior art includes steering wheels in which a driver air bag "floats" relative to the steering wheel armature on a spring system, and moves toward the steering wheel when the air bag module is pushed, in the process closing one or more switches that activate a vehicle horn. The spring system holds the air bag module away from the steering wheel when the air bag module is not depressed.

[0003] The prior art includes snap-in driver air bag to steering wheel interfaces to reduce assembly costs. These prior art snap-in air bag modules use separate spring systems for the snap-in function and the floating horn function.

SUMMARY OF THE INVENTION

[0004] A steering wheel assembly for a vehicle is provided. The steering wheel assembly includes a steering wheel armature, an air bag module, an electrical switch, and an air bag module retention system. The retention system includes at least one foot and at least one spring. The at least one spring is sufficiently configured to retain the at least one foot in a snap-fit engagement thereby to fasten the air bag module to the armature. Furthermore, the at least one spring is sufficiently configured to bias the air bag module in a first position in which the switch is open, and the at least one spring is configured to deform upon sufficient application of force to the air bag module to allow movement of

the air bag module to a second position in which the switch is closed. The switch may, for example, be operatively connected to the vehicle horn so that sufficient force exerted on the air bag module causes actuation of the vehicle horn.

[0005] Each spring of the air bag module retention system thus performs two functions. First, each spring enables snap-fit engagement of the air bag module to the steering wheel armature to facilitate air bag module installation. Second, each spring acts on the air bag module to cause the air bag module to "float" above the armature to maintain the switch in an open position, and each spring is deformable to allow the air bag module to move relative to the armature to close the switch.

[0006] The features for mounting the at least one spring and providing the at least one snap-in foot between the driver air bag and steering wheel armature may be integrally molded into the air bag module and steering wheel so that no extra parts are needed. Horn switches of numerous constructions can be placed at designated touch down points between the driver air bag module and steering wheel to activate the horn circuit when the driver air bag is depressed. The steering wheel assembly of the invention enables reduced tolerance stack-up and associated build variation that may be caused by intermediate pieces found in the prior art. The air bag module can be disengaged from the steering wheel armature by moving the at least one spring with a tool that is inserted into a slot in the outer show surface of the steering wheel.

[0007] The above features and advantages, and other features and advantages, of the present invention are readily apparent from the following detailed description of the best modes for carrying out the invention when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIGURE 1 is a schematic, partially exploded, perspective view of a portion of a steering wheel assembly having an armature including fastening elements thereon, and an air bag module including complementary fastening elements thereon;

[0009] FIGURE 2 is a schematic perspective view of complementary fastening elements of the air bag module of Figure 1;

[0010] FIGURE 3 is a schematic perspective view of a fastening element of the armature of Figure 1;

[0011] FIGURE 4 is a sectional view of the fastening element of Figure 3 in an engagement scenario with one of the complementary fastening elements of the air bag module of Figure 1;

[0012] FIGURE 5a is a schematic side view of the fastening element and complementary fastening element of Figure 4 fully engaged with one another and with the air bag module in a first position with respect to the armature;

[0013] FIGURE 5b is a schematic side view of the fastening element and complementary fastening element of Figure 5a with the air bag module in a second position with respect to the armature;

[0014] FIGURE 6 is a schematic perspective view of the fastening element and complementary fastening element of Figures 5a and 5b; and

[0015] FIGURE 7 is a schematic perspective view of an alternative armature and spring element configuration.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] Referring to Figure 1, a steering wheel armature 10 includes a base 14, a rim 18 and a plurality of spokes 22 interconnecting the base and the rim. A plurality of fastening elements 26 is on the armature 10. Each fastening element 26 includes a spring element 30. A plurality of switches 38 is also mounted to the armature 10, each switch 38 being proximately located to a spring element 30. The switches 38 are electrically connected to a relay coil horn circuit (not shown) and activate a vehicle horn when closed.

[0017] An air bag module 42 includes complementary fastening elements 46 that are engageable with the fastening elements 26 on the armature to provide snap-in engagement of the air bag module to the armature. The fastening elements 26 and complementary fastening elements 46 cooperate to form an airbag module retention system. Referring to Figure 2, wherein like reference numbers refer to like components from Figure 1, the air bag module 42 includes a structural member 50 to which the

complementary fastening elements 46 are rigidly mounted. Each complementary fastening element 46 includes a main body portion 54. A snap-in foot 58 protrudes from the main body portion 54. Each snap-in foot 58 defines a lead-in surface 62, which is rounded in the embodiment depicted, but may be flat within the scope of the claimed invention. Each complementary fastening element 46 also defines two arms 66 extending outward from the main body portion 54 and from the air bag module 42. The arms 66 and the snap-in foot 58 define a notch 70 therebetween. Each foot 58 includes a generally planar surface 74 that partially defines the notch 70.

[0018] Referring to Figure 3, wherein like reference numbers refer to like components from Figures 1 and 2, a fastening element 26 on the steering wheel armature 10 is schematically depicted. Fastening elements 26 are substantially identical to one another. The fastening element 26 is situated where the base portion 14 and a spoke 22 intersect. The spring element 30 is mounted to the armature by a threaded fastener 78. The spring element 30 defines an elongated slot 82. The elongated slot 82 is characterized by a width that is greater than the width of the main body portion 54 of complementary fastening elements 46, as shown in Figure 2. Spring element 30 is characterized by a curvature 31 along its length. A rolled end 86 of spring 30 closes off the elongated slot 82 and forms an engagement portion 90 of the fastening element 26. Integrally formed with spoke 22 are arms 94. Arms 94 form opposing surfaces 98 that are spaced a distance apart from one another. A portion 102 of the spoke forms a surface 106 that is generally perpendicular to opposing surfaces 98. Surfaces 98 and 106 define an open space 108 therebetween. Open space 108 is unobstructed in one direction for insertion of at least one member of the air bag module. More specifically, the open space 108 is sufficiently wide to accommodate the arms 66 of one of the complementary fastening elements 46 as shown in Figure 2. The engagement portion 90 rests against the underside of arms 94.

[0019] In the context of the present invention, "inward" refers to the direction toward the armature, generally parallel to the axis of rotation of the steering wheel; "outward" refers to the direction opposite from the inward direction. "Lateral" refers to a direction that is generally perpendicular to the axis of rotation of the steering wheel.

Thus, for example, the spokes 22 extend generally laterally from the base 14 to the rim 18.

[0020] Referring to Figure 4, wherein like reference numbers refer to like components from Figures 1-3, a complementary fastening element 46 is depicted in a snap-fit engagement scenario with fastening element 26. As the complementary fastening element 46 engages fastening element 26, the lead-in surface 62 of the snap-in foot 58 contacts engagement portion 90 of spring element 30. While the engagement portion 90 in the embodiment depicted is a unitary part of the spring element, it is within the scope of the claimed invention for an engagement portion to be an intermediate piece that is operatively connected to a spring element 30. The lead-in surface 62 contacts the engagement portion 90 at an angle to cause lateral movement of the engagement portion 90 during inward movement of complementary fastening element 46, with resultant deformation of spring 30. The main body 54 of the complementary fastening element 46 extends through the slot 82 of spring element 30 during snap-fit engagement. Continued inward movement of complementary fastening element 46 causes the engagement portion 90 to move along the lead-in surface 62 until it reaches notch 70, as shown in Figure 5a. It may be desirable for the foot 58 and arms 66, or the spring element 30, to include a low friction coating to facilitate relative movement between the engagement portion and the lead-in surface 62, and thereby reduce insertion force required for snap-fit engagement.

[0021] Referring to Figure 5a, wherein like reference numbers refer to like components from Figures 1-4, the air bag module 42 is depicted in a first position in which the air bag module 42 is fastened to the armature 10 of the steering wheel. The notch 70 permits the spring element 30 to return to its original shape. The spring acts against the arms 66 of the complementary fastening element 46 to suspend the main body portion 54 a distance from horn switch 38 and thereby cause the air bag module 42 to "float." Planar surface 74 is oriented at a right angle to the outward direction to prevent engagement portion 90 from leaving the notch 70. At least one member is connected to, or part of, the armature 10 or the air bag module 42, and is configured to restrict movement of the engagement portion 90 thereby to restrict outward movement of the air bag module 42 with respect to the armature. In the embodiment depicted, engagement

portion 90 contacts the arms 94, which restrict outward movement of the engagement portion.

[0022] Outward movement of the air bag module requires outward movement of the planar surface 74. Outward movement of the planar surface in turn requires outward movement of the engagement portion, which is restricted in its outward movement by arms 94. Thus, arms 94 and engagement portion 90 act to retain the air bag module to the armature 10 by restricting outward movement of each complementary fastening element 46.

[0023] Referring to Figure 6, wherein like reference numbers refer to like components from Figures 1-5a, arms 66 of the complementary fastening element 26 are in the open space 108 between the arms 94 of the fastening element 26 so that surfaces (shown at 98 in Figure 3) of the arms 94 prevent movement of the air bag module in first and second lateral directions to prevent rotation of the airbag module. Thus, the air bag module retention system includes surfaces 98 configured to prevent rotation of the air bag module with respect to the steering wheel armature by restricting relative movement between at least one member, i.e., arms 66, and surfaces 98. Similarly, surface 106 restricts movement of the arms 66 in a third lateral direction to prevent radial movement of the airbag module with respect to the steering wheel armature. In the context of the present invention, a "member" may or may not be a unitary portion of the steering wheel armature or the air bag module. Similarly, a "member" may or may not be a separate piece operatively connected to the armature or the air bag module.

[0024] Referring to Figure 5b, a force F exerted on the air bag module 42 is transmitted via arms 66 to the engagement portion 90 of the spring element 30. The force causes spring element 30 to elastically deform and causes inward movement of the air bag module 42 so that the lower surface of the main body portion 54 presses the switch 38, thereby completing the relay coil horn circuit to actuate the vehicle horn. When force F is removed from the air bag module, the spring element 30 exerts an outward force on the air bag module 42 via arms 66 to return to the first position as shown in Figure 5a. It may be desirable to include a surface, shown at 99 in Figure 3, that functions as a travel stop by restricting inward movement of the air bag module 42 to limit the amount of

force that may be applied to switch 38. Surface 99 restricts inward movement of arms 66.

[0025] In the embodiment depicted, the horn switches 38 are push button switches interconnected by a flexible printed circuit board (not shown). However, those skilled in the art will recognize a variety of switch configurations that may be employed within the scope of the claimed invention. In the context of the present invention, a "switch" includes any two conductive elements that are selectively separable to open a circuit and matable to close a circuit. For example, a switch may comprise a battery "hot" contact located on an electrically-isolated intermediate piece on the air bag module 42, and a grounded contact located on the armature, or vice versa; the battery contact and the ground contact would be sufficiently positioned to touch one another when the air bag module is depressed, thereby closing the switch to actuate the horn. Similarly, the air bag module 42 and/or the armature 10 may form a switch. For example, the structural member 50 of the air bag module may be a conductive material and may be wired to be a "hot" contact, the armature 10 may be grounded, or vice versa. The armature 10 and the structural member 50 would thus form a switch that is closed when the air bag module is depressed to cause contact between the structural member 50 and the armature 10. Those skilled in the art will recognize that the use of electrical insulators would be desirable to electrically isolate the armature and the structural member 50 to prevent horn actuation when the air bag module is not depressed. The use of a membrane switch may also be desirable. Electrical isolators between the airbag module inflator and the structural member 50 may be required for some of the switch configurations.

[0026] It should be noted that the feet 58 do not extend through a hole in the armature 10 for snap-fit engagement. It should also be noted that the armature 10, including arms 94 and portion 102, is designed with a sufficient shape so that only an upper and lower tool is required to manufacture the armature, i.e., there is no die lock condition and hence no slides or lifters are necessary in the casting or molding tools. Similarly, the air bag structural member 50 and the complementary fastening elements 46 are designed with a sufficient shape so that only an upper and lower tool is required to

manufacture the structural member and the fastening elements 46, i.e., no slides are necessary in the casting or molding tools.

[0027] The air bag module can be released from the armature by removing the engagement portion 90 from the notch 70, such as with a tool. Within the scope of the claimed invention, the spring elements 30 may be mounted with respect to either the armature of the steering wheel or to the air bag module prior to assembly of the air bag module to the armature. The complementary fastening elements 46 are preferably integrally molded or cast as unitary parts of the air bag module structural member 50 or the steering wheel armature 10. Similarly, arms 94 and surface 106 are preferably integrally molded or cast as unitary parts of the steering wheel armature 10 or the airbag module 42. Squeak and rattle reducers are preferably employed to minimize noise that may be created by relative movement of the air bag module with respect to the armature.

[0028] Those skilled in the art will recognize a variety of spring element 30 configurations that may be employed within the scope of the claimed invention. For example, the spring element 30 may be a torsion spring formed by a wire and having two legs and a loop between the two legs to reduce the bending moment of the spring. It may be desirable for the spring element to include a piece or a coating of zinc to reduce or eliminate galvanic corrosion of the spring element.

[0029] Referring to Figure 7, an alternative embodiment of a fastening element on armature 10' is schematically depicted. The armature 10' includes snap-fit protrusions 112 that are engageable with holes 116 in spring element 30' to retain spring element 30' to the armature 10', thereby eliminating the need for the threaded fastener 78 of Figure 3. Armature 10' also includes a notch 120 through which a portion of a conductive path for the horn circuit, namely flexible printed circuit board 124, is routed to connect the switch 38 to the relay coil horn circuit. The notch 120 is positioned so that the spring element 30' retains the switch 38 and the portion of the circuit board 124 when the spring element 30' is snap-fit to the armature 10'. Likewise, the notch 120 could be formed in the spring element 30' to retain the printed circuit board.

[0030] Spring element 30' is characterized by two curved portions 128, 132. Spring element portion 126 interconnects curved portions 128, 132, and extends

generally parallel to reaction surface 136. Spring element portion 140 interconnects curved portion 132 and engagement portion 90', and extends generally perpendicular to portion 126. Spring element portion 126 is configured so that, during snap-fit engagement of a foot, an insertion force F is transmitted to engagement portion 90' and spring element portion 140 to cause deformation of the spring element 30' such that portion 126 contacts reaction surface 136 (as shown in phantom at 126'), which restricts inward movement of the engagement portion 90', causing increased lateral movement of engagement portion 90' during snap-fit engagement of a foot. The reaction surface 136 may be on the spring element 30, the armature 10, an intermediate piece, etc.

[0031] Spring element 30' includes a C-shaped feature 148 engageable by a tool (not shown) to deflect the spring element 30' and cause lateral movement of engagement portion 90' to release a foot. It may be desirable to include a "helper spring" that biases the air bag module outward so that disengagement of the air bag module from the armature is facilitated. Engagement portion 90' includes a substantially flat surface for improved engagement with planar surface 74 of notch 76, depicted in Figures 2-5b.

[0032] Referring again to Figure 1, the plurality of spring elements are preferably spaced and configured so that the sum of the vectors of the spring forces exerted on the airbag module equals zero. In other words, the spring elements 30 are located on the armature so that the lateral forces exerted by the spring elements on the air bag module cancel each other out. Alternatively, a guide could be used to restrict the movement of the air bag module to the inward and outward direction. For example, holes formed in the armature 10 may receive rods on the airbag module in a close-fit relationship, allowing inward and outward movement of the rods and air bag module, but limiting or preventing lateral movement of the air bag module. If such a guide is employed, it may be desirable for the "helper springs" referred to above to be coiled around the rods to support the helper springs.

[0033] The plurality of spring elements 30 may be formed from a single piece of material so as to be interconnected for facilitated handling and installation to the steering wheel armature or to the air bag module.

[0034] While the best modes for carrying out the invention have been described in detail, those familiar with the art to which this invention relates will recognize various alternative designs and embodiments for practicing the invention within the scope of the appended claims.